TITLE OF THE INVENTION

High-performance, Low-cost Spread Spectrum Data Access System and Method

BACKGROUND OF THE INVENTION

The preferred embodiments of the present invention generally relate to a wireless communication system. More particularly, the preferred embodiments of the present invention relate to an integrated data access system that radically diminishes the effects of RF interference within spectrum, especially public spectrum, and circumvents the obstacles inherent to the pervasive and reliable deployment of data services within said spectrum. Additionally, the preferred embodiments of the present invention embody the fundamental characteristics of a provider-class data network solution while exhibiting exceptional cost-effectiveness through self-installation and auto-configuration of consumer premises equipment.

In today's increasingly digital world, data solutions that offer the capability for reliable high-bandwidth or ubiquitous data accessibility are tremendously desirable, especially in the context of commercial deployment.

Current high-bandwidth solutions such as Digital Subscriber Line (DSL) or broadband cable are undesirable to consumers and data access providers alike for a variety of reasons, including the fact that the physical deployment and maintenance of such network infrastructures is extraordinarily costly. Additionally, DSL and broadband

cable rely heavily on physical wiring and equipment that may be expensive to install. A "truck roll" to a subscriber premises by a technician is commonly required for activation of service. Additionally, the DSL and broadband cable solutions may not be available to all prospective customers; for example, a DSL solution may be unavailable to a consumer who physically resides in an area that is inaccessible to a Central Office (CO) of the DSL provider. Current wireless data solutions, such as the integration of wireless modem services within existing cellular systems may be somewhat less costly to deploy. However, such services typically provide substandard data rates, sluggish performance, assert-pricey service fees, are impractical to integrate with other data devices, and are thus still undesirable.

Given the increased proliferation of spread spectrum data components such as wireless LANs (WLANs), recent efforts have been made to convert this nascent technology and its standards into an effective fixed wireless broadband solution. The comparatively low cost of material components coupled with its capacity for transmission within license-exempt spectrum, commonly regarded as "public spectrum," have rendered spread spectrum data transmission as an emergent alternative for broadband accessibility.

However, numerous inefficiencies plague the practical deployment of this technology as a viable wireless alternative for data accessibility. Acute RF interference resulting from the obligatory co-existence of spread spectrum devices, especially within public spectrum, severely degrades the reliable transmission of data, consequently restricting the capability of pervasively deploying a reliable wireless data access infrastructure. Additionally, the data capacities inherent to a standard spread spectrum

access node do not offer the scalability required of a provider-caliber data access service. Also, the limited transmission range characteristics of standard spread spectrum components that comply with the specified requirements for operation do not typically provide the coverage area essential to a provider-caliber wireless data access service. Also, the provisional and network management functionality indicative of a provider-caliber data access service is either grossly deficient or non-existent within available spread spectrum components. Moreover, the security features warranted in a provider-caliber data access service, such as the effective integration of security measures that prevent theft of service, cloning of equipment, and the widespread compromise of transmitted data, are fundamentally absent from available spread spectrum components. Furthermore, existing outdoor point-to-multipoint spread spectrum data access systems that are intended as a "last mile" data solution typically require the visit of a technician for device installation and service provisioning, thereby adding additional logistical expense comparable to the DSL and broadband cable service deployments referenced above.

Thus, a need has long existed for a data access solution that offers reliable wireless data connectivity and the capacity for high-bandwidth data transmission. A need has also long existed for such a solution that can be expeditiously and cost-effectively deployed without compromising the performance required of a provider-caliber data access system. Additionally, a need exists for such a solution to substantially seamlessly integrate with a variety of other data networks for the purpose of establishing an amalgamated data service with pervasive accessibility.

If spread spectrum devices are employed by a data access solution for the purpose of reliable data transmission in public spectrum, a need exists for the radical circumvention of RF interference inherent to the public spectrum. Also, a need exists for such a solution to improve the data capacities and scalability of a data access and retrieval system. Additionally, a need exists for such a solution that increases the transmission range and service area of a data service. Furthermore, a need exists for such a solution that offers the ability to provision and manage the network elements of a data access system in a manner indicative of a provider-caliber solution. Moreover, a need exists for such a solution that effectively guards against the compromise of transmitted data as well as the ability to combat theft of service.

Finally, a need has also long existed for such a solution that can be installed and provisioned by the intended subscriber of the data access system and does not require a technician to install equipment at the subscriber premises.

SUMMARY OF THE INVENTION

The preferred embodiments of the present invention provide an integrates spread spectrum data access system. The system may be implemented over a public RF band, yet remain substantially free of in-band interference while at the same time providing high-speed data service at provider-quality rates. The system includes Consumer Premises Equipment (CPE) that is installable by an end-user without the expense of a technician. The system is easily expandable and may be integrated with any of a variety of providers, including DSL and cable head ends.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a low-cost, high performance spread spectrum data access system according to the preferred embodiment of the present invention.

FIG. **2** illustrates an expanded functional view of the network management server according to the preferred embodiment of the present invention.

FIG. **3** illustrates an alternative preferred embodiment of the data access system where the network management server is remotely managed via the internet.

FIG. **4** illustrates an alternative preferred embodiment of the data access system where the network management server communicates with the data network from a remote location via the internet.

FIG. **5** illustrates an expanded functional view of the transmission cell and sectors according to a preferred embodiment of the present invention.

FIG. **6** illustrates an alternative preferred embodiment of the sectors without a power amplifier according to the present invention.

FIG. **7** illustrates an alternative preferred embodiment of the cell sectors without a power amplifier and RF channel filter according to the present invention.

FIG. **8A** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with an MMDS communications network according to the present invention.

FIG. **8B** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with a DSL communications network according to the present invention.

FIG. **8C** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with a cable modem communications network according to the present invention.

FIG. **8D** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with a satellite communications network according to the present invention.

FIG. **8E** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with a fiber optic communications network according to the present invention.

FIG. **8F** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with a dial-up communications network according to the present invention.

FIG. **8G** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with an aircraft communications network or aircraft broadband communications network according to the present invention.

FIG. **8H** illustrates an alternative preferred embodiment of the cell data trunk that is configured for use with an aircraft communications network or aircraft broadband communications network and is managed by the network management server via the internet according to the present invention.

FIG. **9A** includes a table of a preferred embodiment of the segmentation of the United States FCC-authorized spread spectrum frequencies within the 2.4 GHz frequency range according to the present invention.

FIG. **9B** illustrates spread spectrum waveforms within a direct sequence environment that include a frequency plan comprised of three discreet carriers according to the present invention.

FIG. **9C** illustrates a standard spread spectrum cellular network topology within a direct sequence environment according to the present invention.

FIG. **9D** illustrates spread spectrum waveforms within a direct sequence environment that comprise a frequency plan of three carriers that exhibit adjacent channel interference.

FIG. **9E** illustrates spread spectrum waveforms within a direct sequence environment that comprise a frequency plan of two carriers that exhibit co-channel intersymbol interference.

FIG. **9F** illustrates a preferred embodiment of an enhanced spread spectrum waveform within a direct sequence environment that is achieved through the deployment of RF filtering according to the present invention.

FIG. **9G** illustrates a preferred embodiment of additional spread spectrum frequency plans within a direct sequence environment afforded by the implementation of RF filtering according to the present invention.

FIG. **9H** illustrates a preferred embodiment of an enhanced spread spectrum cellular network topology within a direct sequence environment derived from the employment of RF filtering according to the present invention.

FIG. **10** illustrates a preferred embodiment of a frequency optimization utility according to the present invention.

FIG. **11A** illustrates an expanded functional view of the CPE device according to the preferred embodiment of the present invention.

FIG. **11B** illustrates an alternative preferred embodiment of the CPE device without a power amplifier according to the present invention.

FIG. **12** illustrates an alternative preferred embodiment of the CPE device with a wireless communication link according to the present invention.

FIG. **13** illustrates a flowchart that represents a preferred embodiment of an authentication and configuration sequence for initializing a CPE device to the data access system according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates a low-cost, high performance spread spectrum data access system **100** according to a preferred embodiment of the present invention. The data access system **100** includes a network management server **105**, a transmission cell **135** and one or more Customer Premises Equipment (CPE) devices **170.** Multiple network transmission cells **135** may be deployed within the data access system **100** to create an amalgamated data network over a widespread geographic area.

A "data network" may be defined as communication between the elements of the data access system **100**. These elements fundamentally include a network management server **105**, one or more transmission cells **135**, and one or more CPE devices **170** as described above.

The network management server **105** is preferably located at the Network Operations Center (NOC) **130** of the data access system **100**. The NOC is a physical location that functions as a single point of contact to handle configuration, management, and monitoring of the data access system **100**. The network management server **105** communicates with the data network, which may be accessible via a data switch **115**, hub (not shown) or similar device located at the NOC. The network management server is preferably coupled with the switch via an ethernet link **110**. Additionally, the data switch may be integrated with connectivity to the internet **125** via a modem, router, or high-speed circuit **120**, such as a T1 or T3 circuit, especially if connectivity to the internet **125** is a desired service feature of the data access system **100**. Preferably, the network management server **105** includes a variety of application components that may be operationally regarded as "administrative" or "data flow" applications. The preferred embodiment of these network management server **105** applications is disclosed in FIG. **2** below, which illustrates an expanded functional view **200** of the network management server **205**.

The transmission cell **135** is generally located in an area where the point-to-point or point-to-multipoint transmission of the data network is desired. The transmission cell **135** may interface with the data access system **100**, and therefore the data network, via a wired or wireless communication device that may commonly serve as a "data trunk"**138** such as a modem **140**, T1 circuit, or fiber-optic connection. The transmission cell **135** is preferably coupled with the modem **140** via an ethernet link **110**. The modem **140** may directly communicate with the data network by interfacing with a data switch **115** or similar device located at the NOC **130** of the data access system **100**. The transmission cell **135** may provide 360 degrees of transmission coverage for the purpose of communication with one or more CPE devices **170**. The 360 degrees of coverage of the transmission cell **135** may be segmented into multiple cell sectors of a predetermined degree of angular variance. For example, the transmission cell 135 may be segmented into the three cell sectors **150, 155, 160** of 120 degrees each as shown in Figure 1. The transmission cell **135** may be segmented or "sectorized" for the purpose of increasing the gain, range and data capacity of the cell transmission. Preferably, the transmission cell **135** includes a variety of application components that may be operationally regarded as "administrative" or "data flow" applications. These applications may be found in the management element **518** of the transmission cell **135**, as further described below. The preferred embodiment of these transmission cell applications is disclosed in FIG. **5** below, which illustrates an expanded functional view **500** of the transmission cell **135** and the three cell sectors **150, 155, 160**.

The CPE device **170** is generally located in an area where connectivity to the data network is desired, such as a subscriber premises. The CPE device **170** includes a wireless transceiver **175** and one or more communication links **180**. The communication link **180** is

preferably an ethernet communication link, a USB communication link, or an IEEE 1394 FireWire communication link, for example. The CPE device **170** may be attached to a multitude of other subscriber devices **185** such as a personal computer (PC) or other network device such as a data switch or hub (not shown) via the communication link **180**. The CPE device **170** is preferably an effective data routing solution and may also include functionality as a modem. Preferably, the CPE device **170** includes a variety of application components that may be operationally regarded as "attendant" applications. A preferred embodiment of these CPE device **170** applications is disclosed in FIG. **11A** below, which illustrates an expanded functional view **1100** of the CPE device **170**.

Alternatively, the CPE device **170** may be generally regarded as any device that has the capability to effectively communicate with the data network. This includes devices, such as personal computers, handheld or data devices, with integrated or compatible circuitry that allows for wireless communication using the frequencies transmitted within range of the transmission cell **135**.

In operation, the data access system **100** includes the network management server **105** as the primary network device for fundamental administrative tasks. The functionality of the network management server **105** preferably includes the provisioning of network subscribers within the data access system **100**, the authentication of network subscribers, the remote configuration and functional management of transmission cells **135** within the data access system **100**, the monitoring and administration of network operations such as packet routing of the data access system **100**, and subscriber accounting. These tasks may be accomplished via automated operation of the network management server **105** or manual operation by an administrator of the data access system **100** from within the NOC **130**.

Additionally, the network management server **105** may interface with a network administration tool such as RADIUS (Remote Authentication Dial-In User Service) or similar administration application for the purpose of providing substantially seamless and rapid integration of the data access system **100** within a pre-existing data network such as an internet service provider (ISP) network.

The transmission cell **135** transmits data to the CPE device **170** that is located inside one of potentially multiple cell sectors **150, 155, 160** of the network transmission cell. In effect, the transmission cell **135** bridges communication between the CPE device **170** and the data access system **100** at large. The transmission cell **135** may be effectively regarded as a network "point-of-presence" (POP) for one or more CPE devices **170** within the data access system **100**.

The CPE device **170** may communicate with the transmission cell **135** via a wireless transceiver **175** such as a spread spectrum antenna, or similar device that may be commonly regarded as an intentional radiator that communicates with the transmission cell **135**. Additionally, the CPE device **170** may wirelessly transmit data originating from or destined to the transmission cell **135** to other subscriber devices in the manner of a wireless data repeater, bridge or router.

FIG. **2** illustrates an expanded functional view **200** of the network management server **105** according to the preferred embodiment of the present invention. Preferably, the network management server **105** includes a database component **220**, an HTTP daemon **230** that is preferably SSL-compliant, and a TCP/IP daemon **240** for communication with the cell management server **524** referenced in FIG. **5** below. The network management server **105** preferably also includes an operating system **210** that is preferably based upon an open-sourced platform such as Linux or FreeBSD

Additionally, the network management server **105** preferably includes a web front-end interface application **250** that may interact with the HTTP daemon **230** of the network management server **105**. The web front-end interface application **250** allows for the remote operation of the network management server **105**. This provides the ability to configure, manage, and monitor the elements of the data access system **100** using a standard web browser or similar application.

FIG. **3** illustrates an alternative preferred embodiment of the data access system **300** where the network management server **305** is remotely managed via the internet. For example, any device that includes a web browser, such as a personal computer, and is capable of interacting with the data network, using the internet, for example, may remotely manage the administration and configuration of a transmission cell **135** or CPE device **170** within the data access system **100**.

The data access system **300** includes the network management server **305**, the transmission cell **335**, the cell data trunk **338**, the cell sectors **350, 355, 360**, and the CPE device **370** similar to FIG **1**.

The network management server **305** is physically located at the NOC **330**, and may be connected to the internet **325** via an ethernet link **310**, a switch **315**, and a high-speed circuit **320** in similar fashion to FIG. **1**. The transmission cell **135** may communicate with the data network using a modem **340** or other device as a cell data trunk **338** similar to FIG. **1**. Additionally, a data device **327**, such as a personal computer, that includes a web browser application **329** is connected to the internet **325** from a location other than the NOC **330**.

In operation, the web browser application **329** of the data device **327** interacts with the web interface application **250** of the network management server **305** via the internet **325**. In

this manner, the network management server **305** may be remotely operated from a location other than the NOC **330**, allowing for the remote management and configuration of other elements within the data access system **300**, which include the transmission cell **335** and CPE device **370**. Alternatively, the network management server **305** may be physically located anywhere communication with the data network can be attained.

FIG. **4** illustrates an alternative preferred embodiment of the data access system **400** where the network management server **405** communicates with the data network from a remote location via the internet. That is, the network management server **405** may communicate with the data network, which includes the transmission cell **435** and the CPE device **470**, from a location other than the NOC **430** via the internet **425**

The data access system **400** includes the network management server **405**, the transmission cell **435**, the cell data trunk **438**, the cell sectors **450, 455, 460**, and the CPE device **470** similar to FIG **1**.

The network management server **405** may be connected to the data network via the internet **425** using a modem **420**, or integrated into a LAN or WAN that supports accessibility to the internet **425**. The transmission cell **435** may interface with the data network via the internet **425** using a modem **440** or other device as a cell data trunk **438**. Other elements of the data network may also be connected to the data network via the internet **425**. In this manner, the network management server **405** may be physically located anywhere accessibility to the internet **425** is available, allowing for the management and configuration of other elements within the data access system **400**, which include the transmission cell **435** and CPE device **470**. This assumes that the data network has connectivity to the internet **425**, and assumes that the

transmission cell **435** has the ability to communicate with the data network, either through direct connectivity to the network management server **405** or remotely through the internet **425**.

FIG. **5** illustrates an expanded functional view **500** of the transmission cell **135** and cell sectors **150, 155, 160** according to a preferred embodiment of the present invention. Generally speaking, the transmission cell **135** includes a cell data trunk **138** such as a modem **140** or other device for wired or wireless connectivity with the data network of the data access system **100**. The modem **140** is preferably integrated with the application elements of the transmission cell **135** using a data switch **516** or similar device. The modem **140** is preferably coupled with the data switch **516** via an ethernet link **110**. Each of the three cell sectors **150, 155, 160** includes a sector antenna **552, 554, 556**, an RF channel filter **562, 564, 566,** and a power amplifier **572, 574, 576** or booster that preferably incorporates an automatic gain control (AGC) feature. The sector antenna **552, 554, 556** preferably employs a circular polarization pattern. The collective functionality of the antenna, filter, and power amplifier may physically exist as a single, integrated component or operate independently as separate devices.

The RF channel filters **562, 564, 566** may be included for the purpose of deploying more densely populated cellular network topologies within a frequency spectrum, especially "public spectrum", by virtue of increasing the number of non-contentious channel alternatives resulting from the significant diminishment of adjacent channel interference and co-channel intersymbol interference as illustrated in FIG. **9D** and FIG. **9E** below. Additionally, the RF channel filters **562, 564, 566** may be included for improving the overall transmission of the cell sectors **550, 555, 560** by improving the signal-to-noise (SNR) levels, thereby optimizing communication between a sector antenna **552, 554, 556** and a CPE device **170**.

The power amplifiers **572, 574, 576** may be included to improve the RF signal strength for enhanced communications with a CPE device **170** over extended geographical distances. The insertion of a DC injection component (not shown) may be required if the power amplifiers **572, 574, 576** are to interface with a sector antenna **552, 554, 556** via a cable. The power amplifiers **572, 574, 576** in the preferred embodiment may be comprised of a pair of bi-directional circulators. The bi-directional feature improves the transmission sent from the sector antenna **552, 554, 556** to the CPE device **170**, while also improving the transmission sent from the CPE device **170** to the sector antenna **552, 554, 556**. Additionally, the power amplifiers **572, 574, 576** may also include an automatic gain control (AGC) feature. Automatic gain control allows for a fixed output of gain, usually measured in dBm. Inclusion of an AGC power amplifier between an access node **542, 544, 546**, whose intentional radiator may emit an arbitrary level of gain, and a sector antenna **552, 554, 556** produces a fixed level of transmission gain. This feature allows for the open integration of access node devices that may emit a variety of gain levels within the intermediate frequencies while ensuring that the transmission of the cell sectors **550**, **555**, **560** complies with the specification requirements of spread spectrum operation.

The transmission cell **135** preferably includes three access nodes **542**, **544**, **546** that may operate using spread spectrum transmission such as an IEEE 802.11b ("Wi-Fi") or IEEE 802.11a compliant access point (AP), for example. The access nodes **542, 544, 546** may transmit in a variety of modulations, including direct sequence spread spectrum (DSSS), frequency hopping spread spectrum (FHSS), Complementary Code Keying (CCK), and Orthogonal Frequency Division Multiplexing (OFDM). A modulation that makes use of phased-array antenna technology may also be included. The access nodes **542, 544, 546** may also employ a variety of media access controller configurations (MAC), including 802.11a, 802.11b, and 802.11g, for

example. A MAC, such as an adaptive dynamic polling MAC, that may circumvent performance degradation issues inherent to CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) transmissions, such as the performance degradation attributed to "hidden nodes" within a spread spectrum environment, may also be included. The access nodes **542**, **544**, **546** are generally integrated with each corresponding cell sector and may interface with other elements of the cell via a data switch **516** or similar device. The access nodes are preferably connected to the data switch **516** via an ethernet link **510**. The RF output of the access nodes **542, 544, 546**, including the intermediate frequencies (IF frequencies), preferably interfaces with the components of the cell sectors **550, 555, 560** via a low-loss coaxial cable **580**.

Additionally, the cell preferably includes a management element **518**. The applications **520-534** of the management element **518** are preferably integrated into a single physical element and connected to a data switch **516** or similar device via an ethernet link. However, one or more of these applications **520-534** may operate independently as separate physical devices and may be connected to the data switch **516** via an Ethernet link. These applications **520-534** may be operationally regarded as "administrative" or "data flow" applications, for example. The applications **520-534** of the management element **518** preferably include a firewall **522**, a cell management server (CMS) **524**, a frequency optimization utility **526,** an encryption method **528** or similar security protocol that includes certificate-based authentication through the usage of public keys at the IP layer, such as IPSec or Layer 2 Tunneling Protocol (LT2P), a DHCP server **530**, a database component **532**, and a cache server **534**. The management element **518** preferably includes an operating system **520** that is preferably based upon an open-sourced platform such as Linux or FreeBSD. The management element **518** may also include other

applications, such as applications that are commonly regarded as "administrative" or "data flow" applications, for example.

The firewall **522** preferably prevents the unauthorized routing of data traffic originating from external data networks of the data access system **100** through the transmission cell **135**. The firewall **522** ensures that bi-directional data communication between the transmission cell **135** and the rest of the data access system **100**, including data from the internet **125**, conforms to specified security parameters.

The cell management server **524** preferably routes data traffic of the data access system **100**. That is, it preferably targets the transmission of data traffic to its respective cell sectors **150, 155, 160** of CPE devices **170**. This may aid in the precise routing and transmission of data traffic to CPE devices **170** of a particular cell sector **150, 155, 160**, thereby improving the RF transmission efficiency and data performance of a given transmission cell **135**. The cell management server **524** may also preferably employ restrictions pertaining to the operation or performance of a given CPE device **170**, such as "traffic shaping" or "rate limiting." That is, the cell management server **524** may preferably regulate the peak data rate for communication between the CPE device **170** and the transmission cell **135**. Additionally, the cell management server **524** may preferably provision, authenticate, and manage a CPE device **170** of the data access system **100**. For example, the cell management server **524** may query the database component **532** for verification of authentication records to compile subscriber configuration packets for CPE devices **170**. The cell management server **524** may also preferably query the DHCP server **530** for compiling DHCP configuration packets of authorized CPE devices **170**. The cell management server **524** may also preferably interface with a certificate-based encryption method **528**, similar to the encryption method **1134** of the CPE device **170**, for the

purpose of transmitting a secure subscriber configuration packet to the CPE device **170**, as well as for the secure bi-directional communication of data between the CPE device **170,** the transmission cell **135** and other components of the data access system **100**.

The frequency optimization utility **526** preferably allows the transmission cell **135** to dynamically optimize the transmission of one or more cell sectors **150, 155, 160**. A preferred embodiment of the frequency optimization utility **526** is disclosed in FIG. **10** below.

The DHCP server **530**, preferably via interface with the cell management server **524,** preferably compiles the TCP/IP parameters of a given CPE device **170**. These parameters preferably include the IP address, subnet mask and DNS server configuration for the CPE device **170**.

The database component **532** preferably stores the active configuration and authentication parameters of a given CPE device **170**. These parameters preferably include an IP address, routing configuration, DHCP configuration, DNS configuration, firewall configuration, operational restrictions, and the account status of an intended subscriber, if applicable. The database component **532** of the management comp may be updated

The cache server **534** preferably stores popular DNS records of the CPE devices **170**, and selected DNS records of the data access system **100** at large. The DNS records resolved by the cache server **534** are consequently cached locally at the transmission cell **135**, resulting in reduced data traffic across the transmission cell **135.** This may improve the efficiency of the transmission cell **135** and provide an enhanced user experience for the intended subscriber of the data access system **100**.

In operation, the transmission cell **135** transmits to and receives data from the data network via a cell data trunk **138** such as a modem **140** or other device for wired or wireless

connectivity. The modem **140** may communicate with the transmission cell **135** through integration of the data switch **516** via an ethernet link **110**. The data switch **516** interfaces with the spread spectrum access nodes **542, 544, 546**. Data traffic passing bi-directionally through the access nodes **542, 544, 546** and the modem **140** via the data switch **516** may be managed and filtered using the applications **520-534** of the management element **518**.

Data then passes from the RF output of the access nodes **542, 544, 546** to the power amplifiers **572, 574, 576,** the RF channel filters **562, 564, 566**, and then to the sector antennas **552, 554, 556** where the data may be transmitted to a CPE device **170**.

The components that comprise the cell sectors **150, 155, 160** and the transmission cell **135** are preferably combined into a single, integrated package that may be quickly installed at a network cell site. Preferably, the sector antennas **150, 155, 160** provide 6dBi to 12dBi of gain, but may operate over a wide range of gain values that comply with the specification requirements of spread spectrum operation.

Although the preferred embodiment of the network transmission cell **135** includes three spread spectrum access nodes **542, 544, 546** and three sector antennas **552, 554, 556** providing three sectors **150, 155, 160** of transmission coverage per cell, a greater or lesser number of access nodes, cell sectors configurations, and antennas may be used.

Although the preferred embodiment of the cell sectors **150, 155, 160** of FIG. **5** illustrates the inclusion of a power amplifier **572, 574, 576** in a given transmission cell **135**, a variance of power amplification deployments may be used within the given transmission cell **135** as an alternative embodiment of the cell sectors **150, 155, 160**. For example, one of the cell sectors **150, 155, 160**, such as RF sector **150**, may require the inclusion of a power amplifier **572** to aid in circumventing potential RF transmission interference within the RF sector **150**. Such

interference may exist, for example, due to unfavorable terrain, such as dense foliage, that may be uniquely pervasive within the RF sector **150**. In the given example, only one RF sector, namely RF sector **150**, would require a power amplifier.

FIG. **6** illustrates an alternative preferred embodiment of the cell sectors **600** without a power amplifier according to the present invention. In some instances, a power amplifier **572, 574, 576** may occasionally be regarded as undesirable. In some operating environments, the power levels that such an amplifier emits may create adverse communication effects, such as an increased RF noise level and diminished signal-to-noise levels, thereby impeding optimal communication between a sector antenna **552, 554, 556** and a CPE device **170**. A sector antenna **552, 554, 556** and a RF channel filter **562, 564, 566** are included.

FIG. **7** illustrates an alternative preferred embodiment of the cell sectors **700** without a power amplifier and RF channel filter according to the present invention. The exclusion of a power amplifier **572, 574, 576** is for the same intention as cited in FIG. **6**. Under certain deployment scenarios, reduced channel separation resulting from the inclusion of an RF channel filter **562, 564, 566** as illustrated in FIG. **9G** below may potentially be regarded as undesirable or unnecessary. For example, an instance may exist where a transmission cell **135** may not require the enhanced channel alternatives as afforded through the implementation of an RF channel filter **562, 564, 566**. This scenario may be applicable in an instance where a singular transmission cell **135** is to function as the sole point of transmission within the data access solution **100**. Given a single-cell RF topological deployment of the data access solution **100**, potential interference resulting from the implementation of multiple RF cell topologies or other spread spectrum devices may not be applicable. A sector antenna **552, 554, 556** is included.

Preferably, the transmission cell **135** of the data access system **100** is as an element that is open and agnostic towards a variety of cell data trunks **138**. That is, the transmission cell 125 may provide connectivity with a variety of cell data trunks 138. Consequently, an array of cell data trunks **138** may preferably be integrated within the data access system **100** for the purpose of establishing an amalgamated data network with pervasive wireless accessibility. Such an amalgamated data network may be managed from a single source, preferably via the network management server **105**. Additionally, a homogenous CPE device **170** that exhibits a uniform configuration routine would preferably be issued to prospective network subscribers, regardless of the data trunk faction implemented at the transmission cell **135**.

The integration of the transmission cell 135 of the data access system 100 with a variety of cell trunks is illustrated below in Figs. 8 A-F below.

FIG. **8A** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with an MMDS communications network **818** according to the present invention. A transmission cell **135** that is similar to the cell in FIG. **1** includes a cell data trunk **138** comprised of a wireless modem **814,** and in particular an MMDS (or LMDS) modem for use with a wireless service that utilizes the MMDS frequencies or channels. The MMDS modem **814** may be coupled with a corresponding MMDS transceiver **816** and at least one MMDS antenna **817** for sending and receiving signals to an MMDS communications network **818**. The MMDS modem **814** is preferably connected to the transmission cell **810** via an ethernet link **811**. The MMDS modem may interface with a point-of-presence (POP) or network operations center (NOC) of the MMDS communications network **818** via MMDS signal transmission **819**. Multiple MMDS modems **814** may be coupled to the transmission cell **810** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **810**.

Additionally, other microwave frequencies, such as the 5 GHz Unlicensed National Information Infrastructure (UNII) frequencies, may be deployed as a data trunk in similar fashion using related devices.

FIG. **8B** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with a DSL communications network **828**. The transmission cell **135** includes a data trunk **138** that is comprised of a DSL modem **824** for interfacing with a DSL communications network **828**, which is typically comprised of standard twisted pair wiring. The DSL modem **824** is preferably connected to the transmission cell **820** via an ethernet link **821**. The DSL modem **824** may interface with a POP or NOC of the DSL communications network **828** via a DSL communications line **829**. Multiple DSL modems **824** may be coupled to the transmission cell **820** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **820**.

FIG. **8C** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with a cable modem communications network **838** according to the present invention. The transmission cell **135** includes a cell data trunk **138** comprised of a cable modem **834**, such as a DOCSIS-compliant cable modem, for interfacing with a cable modem-based communications network **838**, similar to those used by some providers such as cable TV companies to provide internet services or a coaxial cable-based data network. The cable modem **834** is preferably connected to the transmission cell **830** via an ethernet link **831**. The cable modem **834** may interface with a POP or NOC of the cable modem communications network **838** via coaxial cable **839**. Multiple cable modems **834** may be coupled to the transmission cell **831** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **135**.

FIG. **8D** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with a satellite communications network **848** according to the present invention. The transmission cell **135** includes a cell data trunk **138** that is comprised of a satellite modem **844** for use with a wireless service that utilizes satellite frequencies or channels. The satellite modem **844** may be coupled with a corresponding satellite transceiver **846**, and at least one satellite antenna **847** or dish for sending and receiving signals to a satellite communications network **848**. The satellite modem **844** is preferably connected to the transmission cell **840** via an ethernet link **841**. The satellite modem **844** may interface with a POP or NOC of the satellite-based communications network **848** via satellite signal transmission **849**. Multiple satellite modems **844** may be coupled to the transmission cell **840** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **840**.

FIG. **8E** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with a fiber optic communications network **858** according to the present invention. The transmission cell **135** includes a cell data trunk **138** that is comprised of a fiber-optic modem **854** for interfacing with a fiber-optic-based communications network **858**. The fiber-optic modem **854** is preferably connected to the transmission cell **135** via an ethernet link **851**. The fiber-optic modem **854** may interface with a POP or NOC of the fiber-optic communications network **858** via a fiber optic line **859**. Multiple fiber-optic modems **854** may be coupled to the transmission cell **850** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **850**.

FIG. **8F** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with a dial-up communications network **868** according to the present invention. The transmission cell **135** includes a cell data trunk **138** comprised of a dial-up

modem router **864**, such as a modem device or router device that interfaces with a standard twisted pair wiring commonly used for telephone service (POTS), for interfacing with a dial-up-based communications network **868** such as the internet. The dial-up modem router **864** is preferably connected to the transmission cell **135** via an ethernet link **861**. The modem router **864** may interface with a POP or NOC of the dialup-based communications network **868** via a telephone line **869**. Multiple dial-up modem routers **864** may be coupled to the transmission cell **860** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **860**. Additionally, other telephony technologies, such as ISDN, may be deployed as a cell data trunk in similar fashion using related devices.

FIG. **8G** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with an aircraft communications network **878** or aircraft broadband communications network according to the present invention. A transmission cell **135** that is similar to the cell in FIG. **1** includes a cell data trunk **138** comprised of an aircraft modem **874** or other aircraft communication device for use with a wireless service that utilizes the frequencies or channels pertinent to aircraft data transmission. The aircraft modem **874** may be coupled with a corresponding aircraft transceiver **876** and at least one aircraft antenna **877** for sending and receiving signals to an aircraft communications network **878**. The aircraft modem **874** is preferably connected to the transmission cell **135** via an ethernet link **871**. The aircraft modem may interface with a point-of-presence (POP) or network operations center (NOC) of the aircraft communications network **878** via aircraft signal transmission **879**. Multiple aircraft modems **874** may be coupled to the transmission cell **135** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **135**.

FIG. **8H** illustrates an alternative preferred embodiment of the cell data trunk **138** that is configured for use with an aircraft communications network **878** or aircraft broadband communications network and is managed by the network management server **105** via the internet **888** according to the present invention. A transmission cell **135** that is similar to the cell in FIG. **1** includes a cell data trunk **138** comprised of an aircraft modem **874** for use with a wireless service that utilizes the frequencies or channels pertinent to aircraft data transmission. The aircraft modem **874** may be coupled with a corresponding aircraft transceiver **876** and at least one aircraft antenna **877** for sending and receiving signals to an aircraft communications network **878**. The aircraft modem **874** is preferably connected to the transmission cell **135** via an ethernet link **871**. The aircraft modem may interface with the internet **888** via aircraft signal transmission **879**. Multiple aircraft modems **874** may be coupled to the transmission cell **135** for the purpose of increasing the bandwidth capacity of the data network serviced by the transmission cell **135**.

Many spread spectrums standards, especially the standards that relate to transmission in the 2.4 GHz ISM or 5 GHz Unlicensed National Information Infrastructure (UNII) frequencies, do not address the substantial limitations of transmitting multiple channels or frequencies from a single location, such as the transmission cell **135** of FIG. **1**.

FIG. **9A** includes a table **900** of a preferred embodiment of a segmentation of the United States FCC-authorized spread spectrum frequencies within the 2.4 GHz Industrial Scientific and Medical (ISM) frequency range. The preferred segmentation identifies eleven channel centers exhibiting 5 MHz of channel separation.

Channel separation is required of some spread spectrum components, especially direct sequence spread spectrum (DSSS) components, for operation at an optimal data rate per channel. For example, many DSSS devices typically require channel separation as much as 25 MHz (that

is, five channels) to effectively transmit at an optimal data rate, such as 11mbps or 54mbps, per channel.

As detailed in FIGS. **9A-H,** one aspect of the preferred embodiment is the implementation of high-resolution channel filtering. By implementing high-resolution channel filtering, the channel spacing may be decreased and the preferred 11 frequency channels shown in FIG. **9A** may be obtained. The preferred channel spacing provides three sets of three channels as well as two additional channels as described below.

FIG. **9B** illustrates three spread spectrum waveforms **912, 914, 916** within a direct sequence environment that include a frequency plan **910** comprised of three discreet carriers according to the present invention. The waveforms **912, 914, 916** exemplify channel center frequencies transmitting at 2412 MHz, 2437 MHz, and 2462 MHz, corresponding to channel one, channel six, and channel eleven of FIG. **9A**, respectively. The waveforms **912, 914, 916** maintain approximately 25 MHz of requisite channel separation as described above. The noise floor **918** generated by the transmitted waveforms **912, 914, 916** is comparatively low and does not meaningfully contribute towards channel interference.

Within many spread spectrum environments, especially direct sequence environments, the frequency plan resulting from a requisite 25 MHz of channel separation yields a restricted cellular network topology that may only include transmission cells **135** exclusively transmitting channel one, channel six, and channel eleven as referenced in the waveforms of FIG. **9B**.

FIG. **9C** illustrates a standard spread spectrum cellular network topology **920** within a direct sequence environment according to the present invention. In this example, the cellular network topology **920** is comprised of three exemplary cells **922-926**. Each of the exemplary cells **922-926** includes a finite frequency plan exhibiting the requisite 25 MHz of channel

separation described above. The frequency plan corresponds to channel one, channel six, and channel eleven of FIG. **9A**, respectively. The ability to deploy densely populated frequency plans that transmit at a maximum specified data rate per sector is consequently restricted due to the inherently limited number of non-contentious channel alternatives.

FIG. **9D** illustrates spread spectrum waveforms **932, 934, 936** within a direct sequence environment that comprise a frequency plan **930** of three carriers that exhibit adjacent channel interference. Adjacent channel interference occurs when the sidebands **938** of a transmitted carrier overlap into an adjacent channel. For example, the sidebands **938** overlap considerably in the illustrated waveforms **932, 934, 936** which exemplify the transmission of channel center frequencies **922, 924, 926** at 2412 MHz, 2427 MHz, and 2442 MHz corresponding to channel one, channel four, and channel seven of FIG. **9A**, respectively. The resulting adjacent channel interference generates an elevated noise floor **929**. The increased noise floor **929** reduces the sensitivity of the communication of the transmission cell **135** to the extent that its transmission coverage area may be significantly reduced. Additionally, when an adjacent carrier is transmitting within 10 MHz or less (that is, two or less channels) of another transmitted channel, communication of both carriers is compromised to the extent that demodulation of their respective RF transmissions may no longer be possible.

FIG. **9E** illustrates spread spectrum waveforms **940** within a direct sequence environment that exhibit co-channel intersymbol interference. Co-channel intersymbol interference occurs when two digital carriers coexist on identical frequencies. For example, the illustrated waveform **940** exemplifies the simultaneous transmission of two identical channel center frequencies **942, 944** at 2432 MHz , each corresponding to channel five of FIG. **9A** above. Both signals are valid digital carriers and require error correction to demodulate the RF transmission. However, the

desired-to-undesired carrier-to-noise (C/N) ratio of the digital carriers illustrated in the waveforms **940** generates unacceptable RF interference. The C/N ratio of one digital carrier must be roughly 10dB greater than another digital carrier before they no longer interfere with one another to achieve successful demodulation of the RF frequency.

To circumvent these inherent RF limitations, the data access solution **100** may benefit from filtering the RF transmission of a spread spectrum transmission cell **135,** for the purpose of increasing the reliability of communication with a device, such as the CPE device **170**. For example, filtering may improve the signal-to-noise rations (SNR) of the CPE device **170**.

Additionally, RF filtering may contribute to the deployment of additional frequency plans within spread spectrum, especially direct sequence spread spectrum, by refining the sidebands of the channel waveforms without compromising transmission bandwidth. For example, filtering may permit channel separation as close as 15 MHz (that is, three channels) in adjacent cell sectors while significantly diminishing the occurrence of adjacent channel interference and co-channel intersymbol interference. This results in the ability to deploy densely populated frequency plans that transmit at an optimal data rate per RF sector **150, 155, 160** by significantly increasing the number of non-contentious channel alternatives. This may aid in the deployment of a more densely populated cellular network topology, especially if the data network transmits using "public spectrum."

FIG. **9F** illustrates a preferred embodiment of an enhanced spread spectrum waveform **950** within a direct sequence environment that is achieved through the deployment of RF filtering according to the present invention. The enhanced waveform **950** exemplifies a filtered channel frequency of 2432 MHz corresponding to channel five of FIG. **9A**. The sidebands **952** of the transmitted channel are significantly refined, radically diminishing the probability of

interference with adjacent channels. Additionally, the enhanced waveform **950** may allow the transmission cell **135** to transmit at an optimal data rate per RF sector **150, 155, 160**, employing a channel separation that is significantly less than what would typically be required of a given spread spectrum frequency. This results in the capability of the transmission cell **135** to transmit using channels that are closer together while restricting the incidence of interference, especially adjacent channel interference and co-channel intersymbol interference illustrated in FIG. **9C** and FIG. **9D**, respectively.

FIG. **9G** illustrates a preferred embodiment of additional spread spectrum frequency plans **960, 970, 980** within a direct sequence environment afforded by the implementation of RF channel filtering according to the present invention. The filtered frequency plans **960, 970, 980** illustrate channel separation of 20 MHz. The waveforms **962, 964, 966** of the first frequency plan **960** exemplify center frequencies transmitting at 2412 MHz, 2432 MHz, and 2452 MHz, corresponding to channel one, channel five, and channel nine of FIG. **9A**, respectively. The waveforms **972, 974, 976** of the second frequency plan **970** exemplify center frequencies transmitting at 2417 MHz, 2437 MHz, and 2457 MHz, corresponding to channel two, channel six, and channel ten. The waveforms **982, 984, 986** of the third frequency plan **980** exemplify center frequencies transmitting at 2422 MHz, 2442 MHz, and 2462 MHz, corresponding to channel three, channel seven, and channel eleven. The relatively low noise floor **968** realized by filtering the waveforms of the filtered frequency plans **960, 970, 980** may allow the transmission cell **135** to transmit at an optimal data rate per RF sector **150, 155, 160**. Note that in this example, channels four and eight are not be utilized and consequently may be used in place of a contested channel within a cell sector for a given cellular network topology.

FIG. **9H** illustrates a preferred embodiment of an enhanced spread spectrum cellular network topology **990** within a direct sequence environment derived from the employment of RF filtering according to the present invention. In this example, the cellular network topology **990** is comprised of three exemplary cells **992-996**. Each of the exemplary cells **992-996** includes a unique frequency plan exhibiting 20 MHz of filtered channel separation as illustrated in FIG. **9G**.

The enhanced cellular network topology **990** of FIG. **9H** may be distinguished from the standard network topology **940** of FIG. **9C** by virtue of the two additional non-contested frequency plans afforded by filtering the sidebands of the waveforms to 20 MHz of channel separation as described above.

Additional frequency plans may be achieved by filtering the channel separation to a greater or lesser degree. For example, filtering the channel centers to 15 MHz may yield a three-sector frequency plan with four possible alternatives. This would effectively provide a cellular network topology exhibiting minimal channel interference that may collectively transmit at an optimal data rate per RF sector using channels one, four and seven, another using channels two five and eight, another using channels three six and nine, and another using channels four, seven and ten.

A frequency optimization utility may allow the data access system **100** to dynamically automate the frequency optimization of one or more cell sectors **150, 155, 160** by determining the most effective cellular network topology for the purpose of minimizing external or internal interference, maximizing the collective signal-to-noise ratios between the transmission cells **135** and the CPE devices **170**, and enhancing overall performance of the data access system **100**.

FIG. **10** illustrates a preferred embodiment of a frequency optimization utility according to the present invention. FIG. **10** illustrates two cellular network topologies, an original cellular

network topology **1010** and an optimized cellular network topology **1020**. Each cellular network topology **1010, 1020** includes six exemplary cells **1030-1040**. The cellular network topology **1010, 1020** is shown with six cells for exemplary purposes only and is not limited to six cells. Each of the exemplary cells **1030-1040** includes three cell similar to the cell sectors **150, 155, 160** of FIG. **1**.

Some spread spectrum cellular transmission, for example, within the 2400 MHz -2483 MHz frequencies and the 5 GHz frequencies takes place in spectrum allocated as "public spectrum." Consequently, such cellular transmissions may be susceptible to interference from other spread spectrum devices residing in the same cell sector and transmitting in an identical or adjacent channel. Under such conditions, a typical resolution may be for the interfering party to adjust its existing transmit channel to a frequency that no longer generates mutual contention. In the case of Direct Sequence Spread Spectrum (DSSS) devices, this involves the selection of a channel at least 10 MHz apart (that is, two channels apart) from the co-channel or adjacent channel in question.

Preferably, each of the exemplary cells in FIG. **10** transmits the maximum allowable dBm power level as specified for acceptable operation. Consequently, in the majority of instances where adjacent channel interference or co-channel intersymbol interference occurs, only the performance of the lower-powered device of the conflicting party would be adversely affected, and not the exemplary cells **1030-1040**. Such low-power devices are typically utilized for indoor commercial applications and inherently maintain a localized range of transmission, usually 500 to 1500 feet in omni-directional deployment.

The typical immediate resolution would result in the party with the lower-powered device manually changing its channel frequency to a frequency that no longer conflicts with the exemplary cells **1030-1040** in that sector.

Atypically, a situation may transpire when another party transmits within perhaps 15 MHz of an exemplary cell **1030-1040** sector channel at an excessive power level that generates significant RF contention within that cell sector. This potentially results in degraded RF transmission of the exemplary cells **1030-1040** to one or more CPE devices **170** within the sector, as the signal-to-noise ratios may be degraded by virtue of adjacent channel interference or co-channel intersymbol interference. Although the operability of both parties' devices may be mutually diminished, the exemplary cells **1030-1040** may employ a frequency optimization utility to maintain unaffected transmission capability.

The implementation of a frequency optimization utility may radically diminish the occurrence of adjacent channel interference and co-channel intersymbol interference generated from the existence of other high-power devices residing in the same cell sectors. The automated deployment of a frequency optimization utility may detect and characterize such contention. A frequency optimization utility may generate a revised frequency plan that collectively optimizes RF propagation to CPE devices **170** throughout the data access system **100.**

In operation, a preferred embodiment of the frequency optimization utility according to the present invention may interact with the frequency optimization utility of one or more CPE devices **170** and may perform aggregate assessment of signal-to-noise ratios for CPE devices **170** within the cell sectors **150, 155, 160** of the data access system **100**. Preferably, at timed intervals that may be specified in the configuration parameters of the frequency optimization utility, the frequency optimization utility may "poll" the collective signal-to-noise ratios of one or more

CPE devices **170** of the transmission cell sectors **150, 155, 160**. If, for example, the cumulative average of the detected signal-to-noise ratios of one or more CPE devices **170** within a sector, for example sector **150** of FIG **.1**, has diminished by a value as specified within the configuration parameters of the frequency optimization utility, the frequency optimization utility may acknowledge the interference and select a different channel, preferably 15 MHz-25 MHz in variance, that does not conflict with the contentious device. Consequently, the channels of the remaining two sectors, for example sectors **155, 160**, may be changed by virtue of implementing a revised frequency plan for the transmission cell **135**. The utility may also employ the reconfiguration of other adjacent cells of the data access system **100** as a result of changing the frequency pattern of a single transmission cell **135**, as further described below.

In FIG. **10**, for example, the cellular network topology **1010** illustrates the exemplary cells **1030-1040** utilizing frequency plans resulting from the integration of RF channel filter components **562, 564, 566** that have refined the transmitted sectors to 20 MHz of channel separation as characterized in FIG. **10G**. The sector transmitting on channel 11 of the northernmost exemplary cell **1034** (highlighted in gray), for example, is experiencing high-power adjacent channel interference or co-channel intersymbol interference. The frequency optimization utility may then register a significant aggregate decrease in the collective signal-to-noise ratios of the CPE devices **170** residing in that specific cell sector. The frequency optimization utility of the exemplary cell **1034** may then attempt to optimize the exemplary cell **1034** by selecting channel 7, which is a non-contested channel. This action effectively rotates the channel plan of the exemplary cell **1034** by 120 degrees in a clockwise direction as shown in the optimized cellular network topology **1020**.

In the optimized cellular network topology **1020**, because exemplary cell **1034** has been rotated, the frequency plan of the other exemplary cells **1030-1040** may also be adjusted. That is, the exemplary cell **1030** is rotated 120 degrees in a clockwise direction, the adjacent exemplary cell **1032** is rotated 120 degrees in a counter-clockwise direction, the adjacent exemplary cell **1036** is rotated 120 degrees in a counter-clockwise direction, the exemplary cell **1038** is rotated 120 degrees in a clockwise direction, and the exemplary cell **1040** is rotated 120 degrees in a counter-clockwise direction.

If, when implemented, the optimized cellular network topology **1020** inadvertently induces frequency contention of another exemplary cell, for example the sector containing channel 11 of the exemplary cell **1040**, the optimized cellular network topology **1020** may then be subsequently adjusted by rotation of the cells another 120 degrees in a similar manner.

Note that adjacent channel interference and co-channel intersymbol interference is not present to any substantial degree within any incarnation of the optimized cellular topology **1020**. That is, the subsequent rotations of the cellular network topology do not induce interference among the cells.

The flexibility of the spread spectrum implementation permits dynamic and instantaneous channel switching of each CPE device **170** residing in its respective sectors **150, 155, 160** of the transmission cell **135** in accordance with the revised frequency plan as directed by the frequency optimization utility. All original configurations of the data access system **100**, in particular the original configurations of the CPE devices **170** such as DHCP and user authentication, may remain unaltered within each sector.

An alternative embodiment of the frequency optimization utility according to the present invention may be to substitute an affected cell with an alternate frequency plan or substitute an

affected sector with an alternate channel, leaving the adjacent cells of a cellular network topology unaffected.

For example, the exemplary cell **1034** of the cellular network topology **1020** may experience high-power adjacent channel interference or co-channel intersymbol interference as described above. The frequency optimization utility may then elect to substitute a frequency plan of channel ten, channel six, and channel two (revised from channel eleven, channel seven, and channel three, respectively). The other exemplary cells **1030-1040** of the cellular network topology **1010** would remain unaffected.

Alternatively, the frequency optimization utility may substitute an affected RF sector **150, 155, 160** of a transmission cell **135** with a channel that does not interfere with adjacent cell sectors or the transmission of adjacent cells. For example, exemplary cell **1034** of the cellular network topology **1010** above may experience high-power adjacent channel interference or co-channel intersymbol interference in the RF sector that actively transmits on channel three. The frequency optimization utility may then elect to substitute channel three with a non-contested channel that maintains a minimum 15 MHz channel separation, such as channel one, channel two, or channel four. The other exemplary cells **1030-1040** of the cellular network topology **1010** would remain unaffected.

FIG. **11A** illustrates an expanded functional view **1100** of the CPE device **170** of Fig 1 according to a preferred embodiment of the present invention. Generally speaking, the CPE device **170** preferably includes a wireless transceiver **1175**, such as a spread spectrum antenna or similar device that may be commonly regarded as an intentional radiator. The wireless transceiver **1175** preferably employs a circular RF polarization pattern.

A preferred embodiment of the CPE device **170** according to the present invention may also include a power amplifier **1110** or booster in the wireless transceiver **1175**. The power amplifier **1110** may be comprised of a pair of bi-directional circulators. The bi-directional feature improves the transmission sent from the CPE device **170** to the sector antenna **552, 554, 556** of a transmission cell **135**, while also improving the transmission sent from the transmission cell **135** to the CPE device **170**. Additionally, the power amplifier **1110** may also include an automatic gain control (AGC) feature. Automatic gain control allows for a fixed output of gain, usually measured in dBm. Inclusion of an AGC power amplifier between the spectrum data conversion component **1112** of the CPE device **170**, whose intentional radiator may emit an arbitrary level of gain, and the wireless transceiver **175** produces a fixed level of transmission gain. This feature allows for the open integration of spread spectrum data conversion components that may emit a variety of gain levels within the intermediate frequencies while ensuring that the transmission of the CPE device **170** complies with the specification requirements of spread spectrum operation

The collective functionality of an antenna and power amplifier **1110** and a wireless transceiver **1175** may physically exist as a single, integrated component or operate independently as separate devices. Preferably, the wireless transceiver **1175** and power amplifier **1110** may be housed within an extended casing **1155** of the CPE device **170** and the integrated unit may be commercially regarded as an "indoor" device. Alternatively, the wireless transceiver **1175** and power amplifier **1110** may interface with the components of the CPE device **170** as separate units via a low-loss coaxial cable (not shown). The insertion of a DC injection component (not shown) may be required if the power amplifier **1110** is to interface with the CPE device **170** via a cable such as a low-loss coaxial cable.

The CPE device **170** may be attached to a multitude of subscriber devices **1185** such as a personal computer (PC) or other network device such as a data switch or hub (not shown) via the communication link **1180**. The communication link **1180** is preferably an ethernet communication link, a USB communication link, or an IEEE 1394 FireWire communication link, for example.

Additionally, the CPE device **170** includes a chipset **1116** such as a PC104 chipset or similar component that may be regarded as a single board computer (SBC) that preferably supports a central processing unit (CPU), such as Intel, AMD, Motorola or ARM microprocessors. Preferably, the CPE device **170** also includes a chipset **1116** that may accommodate at least ten megabytes of flash memory storage and sixteen to thirty-two megabytes of RAM. The CPE device **170** may include a greater or lesser number of flash memory storage and RAM.

In operation, the RF output of the power amplifier **1110** may be converted to a useable data format, such as IP-based ethernet, for use by the chipset **1116**. This may be accomplished via a spread spectrum data conversion component **1112** such as a spread spectrum transceiver, radio modem, or similar device. The spread spectrum data conversion component may take the form of a PCMCIA (Personal Computer Memory Card / International Association), or Compact Flash (CF), which may be connected to the chipset **1116** through a compatible peripheral harness **1114**.

An alternative preferred embodiment of the CPE device **170** may include the spread spectrum data conversion component **1112** as an integrated element within the circuitry of the chipset **1116**.

Additionally, the CPE device **170** preferably includes applications **1120-1134** commonly regarded as "attendant" applications. These applications **1120-1134** are preferably integrated into the flash memory storage and RAM of the chipset **1116**. The applications include a routing application **1122**, a DHCP daemon application **1124**, an HTTP daemon **1126** that is preferably SSL-compliant, a DNS caching daemon application **1128**, a frequency optimization utility **1130**, a pervasive outage reporting application **1132** and a certificate-based encryption method **1134** or similar security protocol that includes certificate-based authentication through the usage of public keys at the IP layer, such as IPSec or Layer 2 Tunneling Protocol (LT2P). The CPE device **170** preferably also includes an operating system **1120** that is preferably based upon an open-sourced platform such as Linux or FreeBSD. The operating system **1120** is preferably integrated into the flash memory storage of the chipset **1116**. The CPE device **170** may also include other applications commonly regarded as “attendant” applications.

In operation, the routing capabilities inherent to the routing application **1122**, such as that which may be found, for example, in a Linux Kernel or FreeBSD compilation, may act as a basic bridge to a single subscriber device **185** such as a personal computer or, alternatively, may act as a functional router for a sizeable local area network (LAN). The operating system **1120** preferably provides the base routing capabilities of the CPE device **170**

Additionally, the routing application **1122** preferably includes an IP masquerade feature. IP masquerading allows any subscriber device **185**, such as a personal computer or data switch, that is connected to the CPE device **170** to appear as the IP address of the CPE device **170** itself. The assignment of a masqueraded IP to a subscriber device **185** by the CPE device **170** renders the malicious compromise of network service, network data, and impersonation of authorized network subscribers exceedingly more difficult. Thus, IP masquerading provides a level of

security several orders of magnitude higher than most broadband routing options, such as those found in the DOCSIS (data over cable service interface specification) standard. Because the CPE device **170** supports IP masquerading, the CPE device **170** may be seamlessly integrated into a pre-existing subscriber network such as a LAN.

Additionally, the routing configuration of the CPE device **170** may be managed either by the administrator of the data access system **100** or the intended subscriber of the CPE device **170**, at the administrator's option. Permitting the routing configuration of the CPE device to be controlled by the administrator of the data access system **100** would offer the administrator the ability to limit the number of subscriber devices **185** that may be connected to a single CPE device **170**. Management of the routing configuration by the subscriber would give control to the subscriber with respect to the integration of the CPE device **170** within a commercial network environment, without the need for additional hardware.

The routing application **1122** may provide comprehensive statistical data reporting in regard to the performance of the CPE device **170** as well as the performance of the data access system **100**. The intended subscriber using the CPE device **170** may access network performance data that is preferably presented in a web-based format that is generated by the HTTP daemon application **1126**. The routing application may also exchange information with the network management server **105** and the management element **518** of the transmission cell **135**. As a result, the routing application **1122** may also contribute to providing the administrator of a data access system **100** with comprehensive statistical data such as overall performance or network congestion. This data is preferably presented in a web-based format and accessed via an HTTP query to the HTTP daemon **230** of the network management server **105**.

At the option of the administrator of the data access system **100**, the routing application **1122** may also employ transparent HTTP caching. Transparent HTTP caching may permit all subscriber devices **185** connected to the CPE device **170** to retrieve cached data content residing on the cache server **534** of the corresponding transmission cell **135** without having to configure the intended subscriber's web browser application.

The DHCP daemon application **1124** preferably allows one or more subscriber devices **185** of an intended subscriber to be automatically configured for use with the CPE device **170**. The DHCP daemon application **1124** configuration may be provided by the cell management server **524** via interface with the DHCP server **530** within the management element **518** of the transmission cell **135** mentioned above, giving the administrator of the data access system **100** control of the network information sent by the DHCP daemon application **1124**.

The HTTP daemon application **1126** performs the initial provisioning of the CPE device **170** which may then be completed by the intended subscriber. Subsequent to configuration of the CPE device **170**, the HTTP daemon application **1126** may assist in providing account information to the intended subscriber. Additionally, the HTTP daemon application **1126** may also generate selected operational statistics of the CPE device **170**, thus permitting a degree of troubleshooting by the intended subscriber. The HTTP daemon application **1126** may also generate a cache server auto-configuration file if the transparent caching feature of the routing application **1122** has been disabled or is not present.

The DNS caching daemon application **1128** may be accessible to all subscriber devices **1185** connected to the CPE device **170**. DNS records resolved by the DNS caching daemon application **1128** may be cached locally on the CPE device **170**, which may result in reduced data traffic across the transmission cell **135**. This may improve the efficiency of the transmission

cell **135**, and provide an enhanced user experience for the intended subscriber of the data access system **100**.

The preferred embodiment of the frequency optimization utility **1130** functions as an integrated application that operates in concert with a frequency optimization utility **526** of the transmission cell **135** and relays transmission information, such as signal-to-noise ratios or data transmission performance, of the CPE device **170** within the corresponding cell sectors **150, 155, 160** of the data access system **100**. The relay of such information to the frequency optimization utility **526** of the transmission cell **135** is preferably at timed intervals that may be specified in the configuration parameters of the **526** utility of the transmission cell **135** and the frequency optimization utility **1130** of the CPE device **170**. The implementation of a frequency optimization utility **1130** may radically diminish the occurrence of adjacent channel interference and co-channel intersymbol interference generated from the existence of other high-power devices residing in the same cell sectors **150, 155, 160** as the CPE device **170**.

The pervasive outage reporting application **1132**, in conjunction with the HTTP daemon application **1126**, may be configured to generate a message, preferably a message in a web browser application during an outbound HTTP query, in the event of an outage within the data access system **100**. For example, an outage in the ability of the CPE device **170** within the data access system **100** to interface with the internet **125**. The outage message may provide the intended subscriber with information stating the reason for the outage, related news, and an expected ETA for the reestablishment of a service. Once the intended subscriber acknowledges the message, the message can be deleted, and the intended subscriber returned to normal, though not completely functional, operation. By implementing a pervasive outage reporting application

1132 at the level of the CPE device **170**, an outage notification can be sent even if the customer has no connectivity to the cell.

The certificate-based encryption method **1134** interfaces with a similar encryption method **528** of the cell management server **524** for the purpose of transmitting a secure subscriber configuration packet to the CPE device **170**, as well as for the secure bi-directional communication of data between the CPE device **170,** the transmission cell **135**, and other components of the data access system **100**.

Alternatively, the applications **1120-1134** of the CPE device **170** may exist as a single software application that may be installed via peripheral disk media onto a subscriber device **185**, such as a personal computer. The applications **1120-1134** may also be acquired and installed onto a subscriber device **185** via the internet, a WAN, or LAN. Additionally, the wireless transceiver **175** may exist as an integrated element of a subscriber device **185**. That is, a subscriber device **185** may initially include an element within its operational scope that may qualify as a compatible spread spectrum wireless transceiver **175** according to the present invention.

FIG. **11B** illustrates an alternative preferred embodiment **1190** of the CPE device **170** without a power amplifier **1110** according to the present invention. In some instances, a power amplifier, such as the power amplifier included in the preferred embodiment of FIG. **11A,** may potentially be regarded as undesirable. The power levels that such an amplifier emits may create adverse communication effects, such as an increased RF noise level and diminished signal-to-noise levels, thereby impeding optimal communication between the CPE device **170** and a sector antenna **552, 554, 556** within one of the designated cell sectors **150, 155, 160**.

Additionally, the communication link **180** of the CPE device **170** may exist as a wireless communication link that communicates with a compatible wireless subscriber device in the manner of a wireless data repeater, bridge or router as illustrated in FIG. **12** below. This wireless subscriber device preferably includes a spread spectrum radio in any of a variety of forms such as a PCMCIA card or Compact Flash (CF) card or a spread spectrum transmission component integrated within a device such as a personal computer, handheld device, or peripheral device. The communication environment between the wireless communication link of the CPE device **170** and one or more wireless subscriber devices may be point-to-point, point-to-multipoint or "ad-hoc."

FIG. **12** illustrates an alternative preferred embodiment of the CPE device **1200** with a wireless communication link **1280** according to the present invention. The wireless communication link **1280** may transmit in a frequency band that does not generate significant adjacent channel interference or co-channel intersymbol interference with the wireless transceiver **175** of the CPE device **170** of Figure 1. The wireless communication link **1280** communicates with a compatible wireless subscriber device **1285**, such as a personal computer or handheld device with an integrated spread spectrum transmission component **1250**.

For example, referring to Figure 1, within a DSSS environment, the wireless transceiver **175** of the CPE device **170** may communicate with the transmission cell **135** using channel 1 (2412 MHz) of the 2.4 GHz (ISM) frequency band while the wireless communication link **1280** communicates in tandem with a compatible wireless subscriber device **1285** using a non-contested channel, such as channel 11 (2462 MHz), within the same 2.4 GHz (ISM) frequency band.

Similar in-band spread spectrum transmission within other frequency bands, such as the 5 GHz (UNII) frequency band, and using other transmission modulations, such as frequency hopping modulation or QAM modulation, is equally applicable.

Alternatively, the wireless transceiver **175** of the CPE device **170** may communicate with the transmission cell **135** using the 2.4 GHz (ISM) frequency band and employing DSSS modulation or a frequency hopping modulation while, concurrently, the wireless communication link **1280** of the CPE device **170** communicates with a compatible wireless subscriber device **1285** employing a frequency hopping modulation, such as frequency hopping spread spectrum (FHSS) or Bluetooth, in the 2.4 GHz (ISM) frequency band. The low-power implementation of frequency hopping modulation in the wireless communication link **1280** allows for interference-free operation of the wireless transceiver **175** to the transmission cell **135** and interference-free operation of the wireless communication link **1280** to a wireless subscriber device **1285** in the same frequency band without a major reduction in connectivity performance of the CPE device **170**.

Alternatively, the wireless transceiver **175** of the CPE device **170** may communicate with the transmission cell **135** using the 5 GHz (UNII) frequency band while the wireless communication link **1280** communicates in tandem with a compatible wireless subscriber device **1285** using the 2.4 GHz (ISM) frequency band. The low-power implementation of 2.4 GHz transmission in the wireless communication link **1280** allows for interference-free operation of the wireless transceiver **175** to the transmission cell **135** and interference-free operation of the wireless communication link **1280** to a wireless subscriber device **1285** without a reduction in connectivity performance of the CPE device **170**.

Alternatively, the wireless transceiver **175** of the CPE device **170** may communicate with the transmission cell **135** using the 2.4 GHz (ISM) frequency band while the wireless communication link **1280** communicates in tandem with a compatible wireless subscriber device **1285** using the 5 GHz (UNII) frequency band. The low-power implementation of 5 GHz transmission in the wireless communication link **1280** allows for interference-free operation of the wireless transceiver **175** to the transmission cell **135** and interference-free operation of the wireless communication link **1280** to a wireless subscriber device **1285** without a reduction in connectivity performance of the CPE device **170**.

Alternatively, the wireless transceiver **175** of the CPE device **170** may communicate with the transmission cell **135** using QAM modulation within a licensed frequency band, such as the MMDS or LMDS frequency band, while the wireless communication link **1280** communicates in tandem with a compatible wireless subscriber device **1285** using spread spectrum modulation within the same licensed frequency band.

The low-power implementation of spread spectrum transmission in the wireless communication link **1280** allows for interference-free operation of the wireless transceiver **175** to the transmission cell **135**, and interference-free operation of the wireless communication link **1280** to a wireless subscriber device **1285** without a reduction in connectivity performance of the CPE device **170**.

FIG. **13** illustrates a flowchart **1300** that represents a preferred embodiment of an authentication and configuration sequence for initializing a CPE device **170** to the data access system **100** according to the present invention.

First, at step **1310**, the intended subscriber unpacks and activates the CPE device **170**. Then, at step **1315**, the CPE device **170** initiates an authentication request to the cell

management server **524** of the transmission cell **135**. This step allows the CPE to obtain an intra-cell private IP address through the use of IP masquerading or similar process. Additionally, this IP address can be derived from a nonspecific numeric pool or predetermined by the administrator of the data access system **100** to implement higher degrees of secure functionality such as additional authentication of the media access controller (MAC) address of the CPE device **170**. Next, at step **1320**, the cell management server **524** queries the database component **532** for authentication record corresponding to the intended subscriber's CPE device **170**. At step **1325**, a determination is made as to whether a valid and active authentication record of the CPE device **170** exists. If an active authentication record of the CPE device **170** is present, then at step **1330**, the cell management server **524** queries the DHCP server and transmits a DHCP configuration packet to the CPE device **170**. Next, at step **1335**, the CPE device **170** configures its data network interface, such as a wide area network (WAN) interface. Then, at step **1340**, the CPE device **170** may initiate a certificate-based transport or tunnel encryption method at the IP layer using a public key, such as IPSec or Layer 2 Tunneling Protocol (LT2P), and requests a subscriber configuration packet from the cell management server **524**. Next, at step **1345**, the cell management server **524** may initiate a certificate-based transport or tunnel encryption method **528** at the IP layer using a public key, such as IPSec or Layer 2 Tunneling Protocol (LT2P), and compiles the subscriber configuration packet. If a previous certificate-based connection has occurred, the cell management server **524** will verify the key of this connection against prior connections. Then, at step **1350**, the cell management server **524** transmits the subscriber configuration packet to the CPE device **170**. Next, at step **1355**, the CPE device **170** configures its routing ruleset and network interface that preferably includes an IP addresses, DHCP configuration, DNS configuration, and firewall configuration for operation. A challenge-

and-response routine may be initiated via the HTTP daemon application **1126** of the CPE device **170**. Finally, at step **1360**, the CPE has completed its configuration.

If, at step **1320**, an active authentication record for the CPE device **170** is not found in the database component **532** of the transmission cell **135**, then, at step **1365**, the cell management server **524** queries the network management server **105** for the authentication record. Next, at step **1370**, a determination is made as to whether a valid and active authentication record of the CPE device **170** exists in the database component **220** of the network management server **105**. If an active authentication record of the CPE device **170** is present, then, at step **1375**, the authentication record is retrieved from the network management server **105**. Flow then proceeds to step **1330**.

If, at step **1370**, the network management server **105** does not contain a valid authentication record of the CPE device **170**, then at step **1380** authentication request is logged and ignored. Finally, at step **1385**, the CPE device **170** is disconnected.

Certain spread spectrum deployments, especially those deployments that transmit within public spectrum, may include components that are relatively inexpensive and readily attainable. Preferably, a variety of preventative measures may reside within the authentication routine of steps **1310-1325** of FIG. **13** to effectively resist theft of service of the data access system **100**, such as theft of service resulting from cloning the CPE device **170** and its operation.

For example, the integration of a challenge-response method may preferably utilize an SSL-compliant HTTP daemon **1126** to provide a fundamental level of security by ensuring that related passwords, if applicable, are not compromised as well as to authenticate the legitimacy of the HTTP daemon **1126** of the CPE device **170**. Additionally, a query may be dynamically generated to preferably include authentication variables such as subscriber identification, an

indelible serial number of the CPE device **170**, and a MAC address of the spread spectrum data conversion component **1112**.

For example, in the case of a non-provisioned CPE device **170** and successive to CPE device activation of step **1310**, the CPE device **170** may preferably query its own serial number as well as the MAC address of the spread spectrum data conversion component **1112**. Additional information related to the transmission cell **135** and corresponding cell sector **150, 155, 160** of the CPE device **170** is also preferably retrieved and recorded within the authentication variables. The authentication variables of the newly-provisioned CPE device **170** are then preferably relayed to the transmission cell **135** and stored as an authentication record within the database component **532**.

If, upon subsequent authentication requests by the CPE device **170**, any of the authentication variables are incorrect, such as the variable that includes the serial number or cell sector **150, 155, 160** of the CPE device **170**, or if the legitimate CPE device **170** has already been authenticated, the CPE device **170** preferably terminates its authentication routine and the failed attempt is preferably logged.

Preferably, the initial authentication routine of a non-provisioned CPE device **170** as described above results in geographically binding each CPE device **170** to the respective transmission cell **135** and cell sector **150, 155, 160** where it is originally activated.

Hence, the authentication routine preferably renders theft of service via cloning of the CPE device **170** decidedly more difficult, given that the attacker is required to compromise a variety of authentication variables while inhabiting the same geographical transmission cell **135** and cell sector **150, 155, 160** as the legitimately provisioned subscriber of the data access system **100**. In effect, this level of security preferably mandates authentication of the CPE device **170**

itself coupled with its geographical location, as opposed to merely verifying the serviceability of a particular subscriber of the data access system **100**.

Some of the points of novelty of the preferred embodiment of the present invention may be expressed in terms as the "Five C's" of a viable provider-caliber data access solution. Namely, these are Cost, Capacity, Coverage, Control, and Compliance. Some of the present points of novelty with regard to each of the Five-C's is further discussed below. Currently, no spread spectrum access solution collectively incorporates the features discussed below.

With regard to cost, the preferred embodiment's solution elements (CPE, Cell) may maximize value by incorporating standard off-the-shelf or "Wi-Fi-compatible" components that are cost-effective and readily available whenever possible. This is referred to above with reference to the access node component **542, 544, 546** disclosure of FIG. **5** as well as the spread spectrum data conversion component **1112** disclosure of FIG. **11A**. Additionally, because the present solution is preferably designed modularly, the preferred embodiment of the present solution includes the ability for the solution to transmit over different frequencies or modulations through a simple replacement of off-the-shelf components. The preferred embodiment of the present solution may transmit at 2.4Ghz or 5.8Ghz and may use any of Direct Sequence Spread Spectrum (DSSS) modulation, Frequency Hopping Spread Spectrum (FHSS) modulation and Orthogonal Frequency Division Multiplexing (OFDM) modulation.

With regard to capacity, the preferred embodiment of the present solution may incorporate client-side and server-side DNS and/or HTTP caching which contributes towards conserving transmission bandwidth. Caching increases the user capacity of the data network as described above with regard to the cache server **534** of FIG. **5** and the DNS caching daemon **1128** of FIG. **11A**. Additionally, the solution preferably incorporates a proprietary spread

spectrum polling medium access layer (MAC), as discussed above, that provides for the effective and equitable distribution of bandwidth among network clients. Additionally, the integration of sectorization and/or channel filtering (collectively disclosed in FIGs **1, 3, 4, 5, 6, 7, 9C, 9F, 9G, 9H, 10,** above) within a single, integrated spread spectrum access solution significantly contributes towards the dense user deployment of a reliable spread spectrum data access solution by increasing the number of available channel alternatives for spread spectrum data transmission. Thus, the system may be optimized even after deployment to respond to interference or user conditions to optimize data capacity. Additionally, the integration of a certificate-based encryption method (as discussed above as **528** of the transmission cell of FIG. **5** and **1134** of the CPE device of FIG **11A**) within the data stream of the spread spectrum access solution significantly reduces the occurrence of service compromise, which would appreciably diminish the available bandwidth of the data access solution.

With regard to coverage, as with capacity, service coverage is extensively enhanced via the integration of sectorization and channel filtering (as collectively disclosed above in FIG **1, 3, 4, 5, 6, 7, 9C, 9F, 9G, 9H, 10**) within a single, integrated spread spectrum access solution. Sectorization significantly contributes towards the pervasive deployment of a reliable spread spectrum data access solution by increasing the number of available channel alternatives for spread spectrum data transmission. Additionally, the implementation of a spread spectrum frequency optimization utility as illustrated in FIG. **10** radically diminishes the occurrence of adjacent channel or co-channel interference that is common within spread spectrum transmission environments, and thus also increases coverage. Additionally, the integration of an AGC power amplifier (as shown above as **572, 574, 576** within the transmission cell sectors of FIG **5** and / or the AGC power amplifier **1110** of the CPE device of FIG **11A**) increases the range of spread

spectrum transmission. To date, no other spread spectrum solution offers power amplification as an integrated component of its operational capacity or scope. The integrated AGC capability also pertains to the category of compliance and is further discussed below.

With regard to control, the integration of a central management element (i.e. the Network Management Server **200** of FIG. **2**) that remotely authenticates, provisions, and manages the functionality of a spread spectrum network is a vast improvement over the prior art. Additionally, the use of a central management element that operates regardless of the data trunk used between the cell and the management element is complete absent from the prior art. That is, the preferred embodiment of the present solution is "provider agnostic" and may be implemented with any trunk, including DSL, cable, optical, microwave, etc. all within the same network. No other solution provides similar flexibility. Additional functionality including remote management of the transmission cell, CPE provisioning, user authentication, IP address allocation, routing ruleset, and user bandwidth limitations is also novel. Additionally, the option of integrating the management element so that the management element resides at the cell (as discussed above with reference to FIG. **5**) is also not found in the prior art. Additionally, no other spread spectrum solution offers a management element that includes a firewall, frequency optimization utility, encryption method, database component, and cache server as an integrated facet of its operational capacity or scope. Additionally, no other solution offers pervasive management of the data access system via a standard web browser (such as the Web Interface Application **250** of FIG. **2**) that remotely manages the Network Management Server **200** of FIG. **2** and consequently the various elements (which includes the transmission cells and subscriber CPE) of the data access system at large. Finally, no other solution offers the authentication or provisioning routine of FIG. **13** that effectively binds each CPE to its respective cell and cell

sector, rendering theft of service via theft of the CPE device or cloning of the CPE device decidedly more difficult.

With regard to compliance, compliance largely relates to the FCC specification for spread spectrum transmission within the 2.4Ghz ISM or 5.8 GHZ UNIII bands. More particularly, the specification that directly pertains towards the allowed power level of transmission (measured in dBm) within said spectrum. The fact that the preferred embodiment of the present spread spectrum access solution that incorporates an AGC power amplifier (**572, 574, 576** within the transmission cell sectors of FIG. **5** and the AGC power amplifier **1110** of the CPE device of FIG. **11A**) as an integrated element of the data access solution at large provides a novel feature to optimize communication while ensuring compliance. As described above, the incorporation of the AGC allows for a fixed output of gain which allows for a variety of gain levels within the intermediate frequencies while ensuring that the transmission of the cell sectors comply with FCC regulation. Additionally, the incorporation of an AGC amplifier as an integrated element of the CPE is also novel and proves for the optional integration of spread spectrum conversion components operating at a variety of gain levels.

While particular elements, embodiments and applications of the present invention have been shown and described, it is understood that the invention is not limited thereto since modifications may be made by those skilled in the art, particularly in light of the foregoing teaching. It is therefore contemplated by the appended solution allows the integration of a web-based front-end utility (claims to cover such modifications and incorporate those features that come within the spirit and scope of the invention.